EMC126

INSTRUCTION MANUAL

INSTRUCTION MANUAL
FOR
UHF IMPULSE GENERATOR
MODEL 93453-1

MANUAL NO. 1-500783-285

SINGER
INSTRUMENTATION

INSTRUCTION MANUAL
FOR
UHF IMPULSE GENERATOR
MODEL 93453-1

MANUAL NO. 1–500783–285

For use with Model 93453–1
Serial No. 121 and above.

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SINGER
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The Singer Company, Los Angeles Operation • 5340 Alla Road, Los Angeles, Ca. 90066

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2. Serial Number
3. Description of trouble(1)
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Has maintenance action been previously requested.
7. Other comments.

(1) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data.

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Figure 1-1. Impulse Generator, Model 93453-1

Section I

INTRODUCTION

1.1 SCOPE OF MANUAL

This manual provides operating and maintenance instructions for the Model 93453-1 Impulse Generator.

1.2 PURPOSE AND USE OF EQUIPMENT

The Model 93453-1 Impulse Generator is a broadband impulse generator (100 Hz to 35 MHz). It is an ideal unit for the following uses: test for broadband electromagnetic interference (EMI) susceptibility of receivers, bandwidth determination, receiver alignment, measurements of RF intermodulation, transient response study, and signal source for evaluation of spectrum analyzers.

1.3 GENERAL DESCRIPTION

This instrument is a rugged combination of solid state components and vacuum tubes. It is designed to operate from either 115 Vac or 230 Vac, 50 Hz to 400 Hz power.

1.4 SUPPLIED ACCESSORIES

The items listed in Table 1-1 are furnished with the Model 93453-1 Impulse Generator.

Table 1-1. Supplied Accessories

Quantity	Device	Singer Part/Model No.
1	Instruction Manual	1-500783-285
1	40 dB Pad	RFA-40

1.5 OPTIONAL ACCESSORIES

Accessories available for use with the Model 93453-1 follow:

a. RF Cable, Model 94596-1, 6 ft. with type BNC connectors.

Section II

SPECIFICATIONS

2.1 INTRODUCTION

This section contains specification information for the Model 93453-1.

2.2 SPECIFICATIONS

Table 2-1 contains the specification data for the Model 93453-1 Impulse Generator.

Table 2-1. Specifications

Characteristics	Specifications
Frequency range:	100 Hz to 35 MHz
Output level:* (Spectral Intensity)	0 dBμV/MHz to 121 dBμV/MHz (1 μV/MHz to 1.1 V/MHz) Level is adjustable throughout a 121 dB range in 0.25 dB steps by means of three front panel step attenuators.
Level accuracy (100 Hz to 35 MHz):	±1 dB
Output load impedance:**	50 ohms
Output receptacle:	Type BNC
Pulse amplitude (max):	Approximately 150 V
Pulse width:	Approximately 10 nanoseconds
Pulse repetition rate:	2 to 100 pulses per second, continuously variable. A single pulse feature is included.

* See Paragraph 5.5 for explanation.
** See Paragraph 4.6.1 for explanation.

Table 2-1. Specifications (Cont.)

Characteristics	Specifications
Pulse polarity:	Reversible by a front panel toggle switch.
Sync output:	Front panel, BNC receptacle -4 V across high impedance -40 mV across 50 ohm load Negative pulse
Power requirements:	105 V to 130 V or 210 V to 260 V, 50 to 400 Hz, approximately 27 VA
Mechanical:	
Dimensions (including knobs and receptacles):	Height: 12.7 cm (5") Width: 24.3 cm (9.5") Depth: 15.5 cm (6.1")
Weight:	3.0 kg (6.6 lbs.)
Environmental:	
Temperature	Operational: -15°C to +50°C (+5° F to +123°F) Non-operational: -50°C to +75°C (-58°F to +167°F)

Section III

INSTALLATION

3.1 INTRODUCTION

This section contains information for 115 V or 230 V operation.

3.2 PREPARATION FOR USE

3.2.1 Bench Operation

The Model 93453-1 Impulse Generator is shipped ready for use as a bench-operated instrument.

3.2.2 115 V or 230 V Operation

The Model 93453-1 Impulse Generator requires ac power of 105 V to 125 V, or 210 V to 250 V, 50 Hz to 400 Hz, approximately 27 VA.

a. Set the 115/230 volt slide switch on the rear panel to the position corresponding to the ac power line voltage.

b. The Impulse Generator is supplied with a 3 AG, 0.4 A, slo-blo fuse for 115 volt operation. For 230 volt operation, the fuse must be changed to 0.2 A.

Section IV

OPERATING INSTRUCTIONS

4.1 INTRODUCTION

This section deals with the functional description of controls, indicators and receptacles, operating instructions, and operating considerations.

4.2 OPERATING CONTROLS, INDICATORS AND RECEPTACLES

All external operating controls, indicators and receptacles of the Model 93453-1 Impulse Generator are located on the front and back panels as indicated by Figure 4-1. Functions are described in Table 4-1 and items are located in Figure 4-1.

Table 4-1. Controls, Indicators and Receptacles

Item	Panel Marking	Description	Function
1	OUTPUT	BNC receptacle (J1)	Provides signal output
2	SYNC	BNC receptacle (J2)	Synchronizing pulse output
3	dB ABOVE 1 μV/MHz	12 position rotary switch (S8)	Controls the output level of the Model 93453-1 throughout a 110 dBμV/MHz range in 10 dB steps
4		11 position rotary switch (S7)	Controls the output level of the Model 93453-1 throughout a 10 dB μV/MHz range in 1 dB steps.

Table 4-1. Controls, Indicators and Receptacles (Cont.)

Item	Panel Marking	Description	Function
5	dB ABOVE 1 μV/MHz	5 position rotary switch (S6)	Controls the output level of the Model 93453-1 throughout a 1.0 dBμV/MHz range in 0.25 dB steps.
6	PULSES/SEC 2 TO 100	Potentiometer (R32)	Controls the pulse repetition rate continuously throughout a 2 to 100 pps range.
7	MANUAL PULSE	Pushbutton switch (S4)	Controls single event pulse.
8	ON	2 position toggle switch (S1)	Energizes the Model 93453-1 Impulse Generator
9	--	Indicator neon bulb (DS1)	Glow indicates equipment is energized; also that high voltage regulator is functioning.
10	PULSE POLARITY + , -	2 position toggle switch (S5)	Provides polarity reversibility to select positive or negative output pulses
11	40 dB ATTENUATOR	Clip	Holder for 40 dB attenuator pad
12	115 V 230 V	2 position slide switch (S2)	Position set according to the power line voltage available
13	.4 AMP .2 AMP	Fuseholder (XF1)	Provides access to a.c. fuse; 0.4 A for 115 V, 0.2 A for 230 V

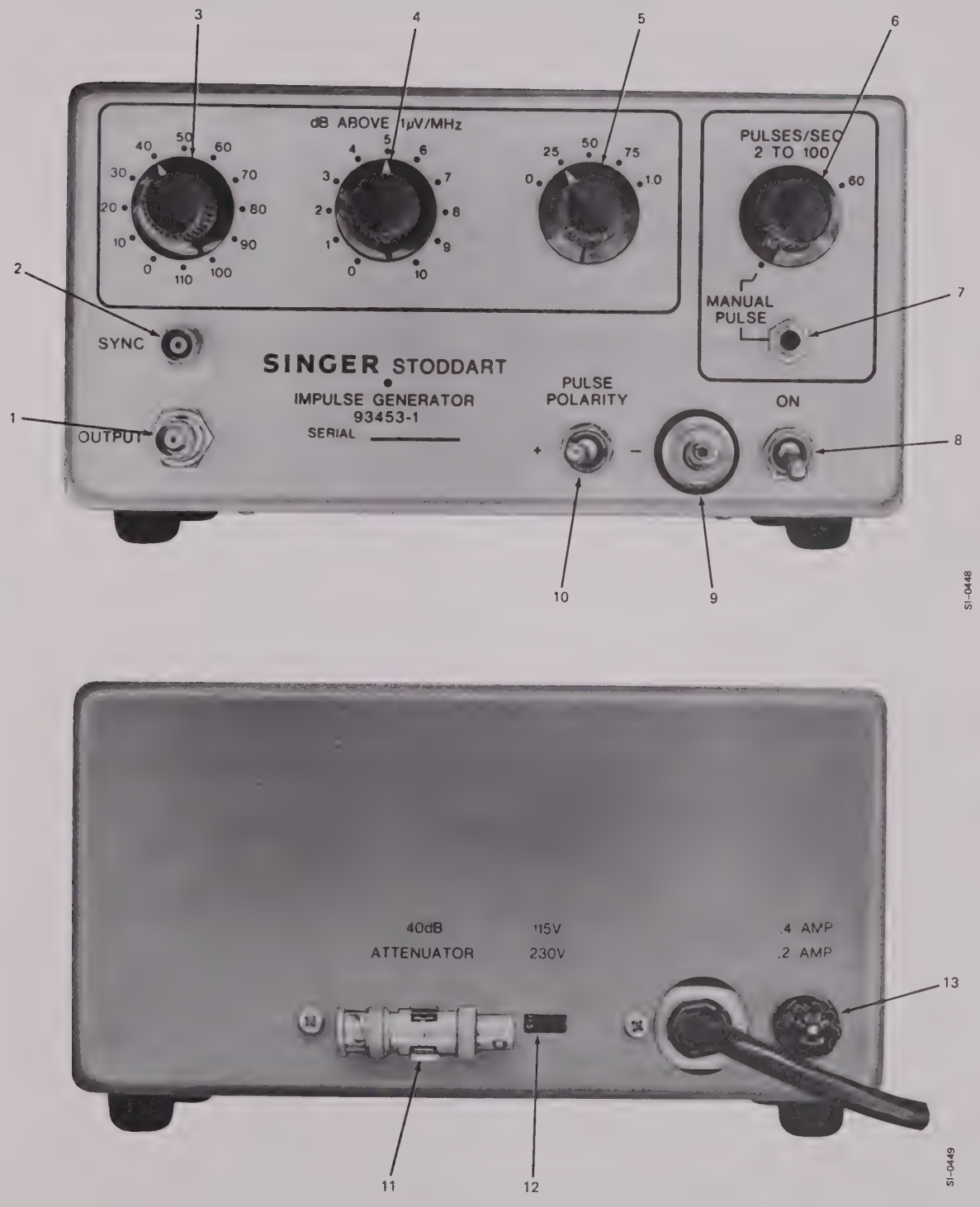


Figure 4-1. Controls, Indicators, and Receptacles, Model 93453-1

4.3 GENERAL OPERATING INSTRUCTIONS

a. Place the Model 93453-1 on a bench or other horizontal flat surface. The instrument will not function satisfactorily if the equipment is tilted greater than 30° from the vertical axis because of mercury switch contact flooding.

b. Connect the power cord to a 115 V, 50 Hz to 400 Hz power source. For 230 V power source operation, see Paragraph 3.2.2.

c. Connect the OUTPUT receptacle of the Model 93453-1 Impulse Generator to the 50 ohm receiver or measuring instrument RF input receptacle using the RF Cable Model 94596-1 or equivalent.

d. Set the PULSE POLARITY switch to + or - position.

e. Set the three attenuator switches to the desired output level in terms of dB above one microvolt per megahertz (dBμV/MHz).

f. Raise the power toggle switch to the ON position. The neon lamp should light.

NOTE:
The impulse generator should not be used if the neon lamp is not illuminated. The lamp indicates "power on" conditions and correct operation of the voltage regulator tubes in the charging voltage circuit.

g. Vary the PULSES/SEC control for the desired pulse repetition rate.

h. When using an oscilloscope it may be necessary to provide a triggering voltage. Connect the Model 93453-1 SYNC receptacle to the external trigger input of the oscilloscope and set the oscilloscope triggering mode to the external negative position.

i. Use the supplied Model RFA-40 attenuator pad at the OUTPUT receptacle when extremely low-level signals free from spurious output are required. Subtract 40 dB from the sum of the three panel attenuator switches to obtain the overall spectral output level. See Paragraph 4.6.5.

4.4 BANDWIDTH MEASUREMENTS

The impulse bandwidth of a receiver or amplifier can be measured at any frequency from 100 Hz to 35 MHz by comparing the sine wave sensitivity of the receiver with its impulse sensitivity. Since the Model 93453-1 produces a flat (±1 dB) spectral output from 100 Hz to 35 MHz, any change in the impulse sensitivity not accompanied by a proportional change in sine wave sensitivity is an indication of a change in bandwidth.

The following procedure can be used for determining the impulse bandwidth of any receiver or amplifier equipped with a Direct Peak or a Peak Slideback detector. (See Paragraph 4.6.4 for method not requiring a special detector circuit.)

a. Set the output level of the impulse generator to some convenient level well above the output display level of the internal noise of the equipment under test. Convert the output level of the Impulse Generator to μV/MHz by the following:

$$\mu V/MHz = \log_{10}^{-1} \frac{(dB\mu V/MHz)}{20}$$

NOTE:
Observe instrument test overload precautions. (See Paragraphs 4.6.1 and 4.6.2.)

b. Without changing any equipment controls, substitute a sine wave (CW) generator with calibrated output level for the Impulse Generator.

NOTE:
The CW generator must have a 50 ohm output impedance and both generators must use the same 50 ohm load. At higher frequencies the same 50 ohm RF cable should be used to ensure that cable losses will be identical.

Tune the CW generator to the center frequency of the equipment under test. Adjust the CW generator output level (no modulation) for the same signal output display level used in Step a. Note and record the CW generator output level in microvolts.

c. The impulse bandwidth of the equipment under test can then be found by dividing the sine wave generator output level in microvolts by the Impulse Generator output level in microvolts-per-megahertz. (Refer to Paragraph 4.6.4 for explanation of impulse bandwidth.)

Example: Impulse Generator level = 40 dBμV/MHz

= 100 μV/MHz, CW gen level = 1 μV,

$$BW = \frac{1}{100} = 0.01 \text{ MHz} = 10 \text{ kHz}.$$

4.5 IMPULSE INTERFERENCE MEASUREMENTS

For EMI/FI Meters not equipped with an internal impulse generator, and having a Direct Peak or a Peak Slideback detector, an external generator such as the Model 93453-1 is extremely useful in the measurement of impulse interference. Its use permits the measurement of impulse signals directly in terms of dB above one microvolt-per-megahertz without involving bandwidth computations. (Refer to Paragraph 4.6.3 for explanation of impulse signal.)

4.5.1 Measuring Impulse Signal Levels Below 121 dBμV/MHz

The following procedure may be used for measuring signal levels that do not exceed 121 dBμV/MHz. (This is the maximum output of the Model 93453-1.)

a. Perform a Peak Slideback or Direct Peak detector measurement of the unknown broadband signal with the EMI/FI Meter. It is not necessary to standardize the gain of the EMI/FI equipment but it is advisable to operate with the lowest attenuator step and the highest receiver gain that is practical. (See Paragraph 4.6.2 regarding overload precautions.)

b. Without disturbing the EMI/FI Meter controls, substitute the Impulse Generator signal for the unknown signal. Adjust the Impulse Generator output level for the same Peak indication noted in Step a.

c. For direct 50 ohm conductive measurements, the unknown signal level is equal to the output level of the Impulse Generator. The output level can be read directly from the attenuator controls and is in terms of dB above one microvolt-per-megahertz bandwidth.

d. For conductive measurements using a current probe, algebraically subtract the current probe transfer impedance in dB from the final reading of Step c to obtain the value of the RF current in terms of dB above one microampere-per-megahertz.

e. When measuring radiated impulse interference with a pick-up device, such as an antenna, add the antenna correction factor in dB to the final reading of Step c to obtain the value of field intensity in dBμV/m/MHz. It is advisable to use the same cable between the signal source and the EMI/FI Meter as is used between the Impulse Generator and the EMI/FI Meter to eliminate the error due to cable losses.

4.5.2 Measuring Impulse Signal Levels Above 121 dBμV/MHz

The maximum output of the Model 93453-1 Impulse Generator is 121 dBμV/MHz. When the unknown signal exceeds this level, the following measurement procedure is recommended.

a. Perform a Peak Slideback or Direct Peak detector measurement of the unknown broadband signal with the EMI/FI Meter. It is not necessary to standardize the gain of the EMI/FI equipment but it is adviseable to operate with the lowest

attenuator step and the highest receiver gain that is practical. (See Paragraph 4.6.2 regarding overload precautions.)

b. Substitute the Impulse Generator signal for the unknown signal and adjust its output level to 121 dBμV/MHz.

c. Adjust the EMI/FI Meter attenuator only as required for an on-scale meter indication and take measurement.

d. Subtract the EMI/FI Meter indication (output meter scale reading in dB plus the attenuator position in dB) of the Impulse Generator output in Step c from the EMI/FI Meter indication of the unknown signal in Step a. This difference in dB, plus 121 dB, is the signal level in dBμV/MHz.

e. When measuring radiated impulse interference with a pick-up device such as an antenna, add the antenna correction factor in dB to the final indication of Step d to obtain the peak value of field intensity in dBμV/MHz. It is advisable to use the same cable between the Impulse Generator and the EMI/FI Meter as between the unknown signal source and the EMI/FI Meter to eliminate the error due to cable losses.

4.6 OPERATING CONSIDERATIONS

The Model 93453-1 Impulse Generator is often used as a reference for the measurement of broadband signals and impulse bandwidth. These measurements can be performed only when the Model 93453-1 is used in conjunction with an EMI/FI Meter or a suitable receiver. The following paragraphs describe some of the characteristics of these measurements and the relationship of the equipments used.

4.6.1 Load Considerations

Observe the following precautions when connecting the Model 93453-1 to a load:

a. A resistive 50 ohm load was used during calibration of the Model 93453-1 impulse output level. Therefore, for accurate output level the load should be 50 ohms and have low VSWR.

b. The load must be capable of withstanding approximately 150 V peak pulse if the maximum output level of the Model 93453-1 is used.

4.6.2 Receiver Requirements

A suitable receiver shall have a 50 ohm input impedance and low input VSWR. Some means of signal output display must be available, e.g. output meter or IF output or video output with oscilloscope display. The receiver should not be easily overloaded by strong signals. Most EMI/FI instruments have all the required features.

When operating with an impulse signal, care should be taken to prevent receiver overload. This is easily detected by noting the receiver output indication obtained by changing the Impulse Generator PULSE POLARITY switch from positive to negative. The generator output level does not change with polarity; therefore any change in receiver output level is caused by receiver overload. Since most receivers have an RF, IF or audio gain control, the input stage may be receiving a strong signal although the receiver output level may be low. Therefore it is good practice to keep the receiver gain high and the Impulse Generator output level low.

4.6.3 Impulse Signal

A pulse is considered 'impulsive' when its duration is short relative to the

period of the maximum frequency to be considered; e.g. 10 ns compared to 28.5 ns (35 MHz). Also, the pulse width must be very much less than the reciprocal of the bandwidth of the detecting instrument. Stated differently, a pulse is considered impulsive when the overall rise time of the detecting instrument is long compared to the pulse duration. The generator output is not considered impulsive when the detecting instrument rise time approaches the pulse duration. For example, with the pulse duration of the Model 93453-1 of 10 nanoseconds, and a bandpass circuit of the same rise time, the equivalent bandwidth would be approximately:

$$B = \frac{0.7}{T} = \frac{0.7}{0.010} = 70 \text{ megahertz}$$

where: B = 3 dB bandwidth in megahertz

T = Rise time of bandpass circuit in microseconds

For all normal applications, the output of the Model 93453-1 generator can be considered impulsive. For the practical detecting or receiving instrument used below 35 megahertz and subjected to an impulsive signal input, the output will be inversely proportional to rise time and directly proportional to the impulse bandwidth.

4.6.4 Impulse Bandwidth

The impulse bandwidth may be derived with the aid of an oscilloscope as follows:

> Divide the peak value of the receiver or amplifier impulse response envelope by the area; this provides an equivalent rectangular response. The reciprocal of the rectangular response width in seconds (derived from the sweep speed) is the impulse bandwidth in Hertz.

Refer to the typical impulse response envelope displayed in Figure 4-2. The width of the equivalent rectangular response is 0.25 ms. The impulse bandwidth is:

$$BW_{imp} = \frac{1}{Tr \text{ secs}} = \frac{1}{0.25 \times 10^{-3}} = 4 \times 10^{3} \text{ Hz} = 4 \text{ kHz}$$

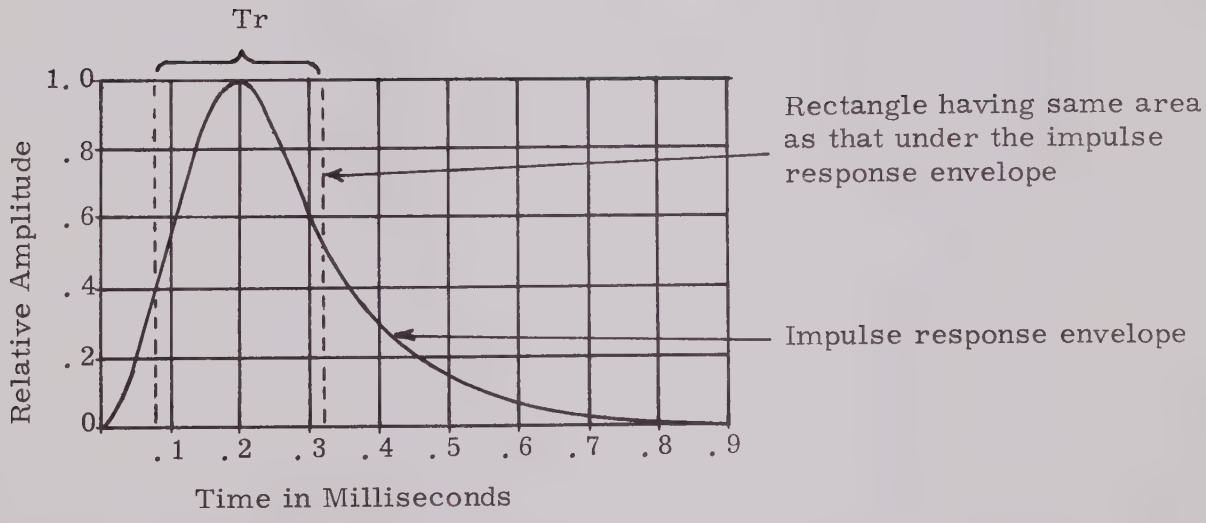


Figure 4-2. Typical Impulse Response Envelope

4.6.5 Low-level Spectral Output

Below the level of 40 dB above 1 μV/MHz the impulse output may exhibit:

a. A difference in output level up to 10 dB between + and - positions of the POLARITY switch.

b. A background noise level of 10 to 20 dB above 1 μV/MHz.

This condition is particularly aggravated for a time (15 minutes to 24 hours) after the mercury switch contacts have been flooded by tilting or upsetting the instrument.

These low-level output problems can be avoided by placing the supplied Model RFA-40 attenuator pad in series with the OUTPUT receptacle and subtracting 40 dB from the sum of the dB settings on the three panel attenuator knobs.

Section V

THEORY OF OPERATION

5.1 INTRODUCTION

This section contains the theory of operation of the Model 93453-1. The information is presented to assist the user in understanding the circuitry employed and is useful in troubleshooting and maintenance of the equipment.

5.2 GENERAL

The Model 93453-1 Impulse Generator produces electrical pulses which are so short in duration as to have a frequency spectrum that is essentially flat from 100 hertz to 35 megahertz. The principle used in this equipment for the production of short pulses consists of charging and discharging a short coaxial transmission line having a $\frac{\lambda}{4}$ resonant frequency of approximately 100 megahertz. The pulse amplitude and the RF power output level can be varied by changing the level of the dc charging potential.

5.3 CIRCUIT ANALYSIS

The instrument consists basically of a regulated power supply, a polarity-reversing switch, three step attenuators, a variable rate generator and an impulse generator. The following operating analysis is referenced to the schematic diagram, Figure 8-1.

5.3.1 Power Supply Circuitry

The self-contained power supply is designed to operate from a single-phase source, 105 V to 130 V or 210 V to 260 V, 50 Hz to 400 Hz. The input power for the impulse generator line charging voltage is obtained from the 500 V secondary winding of the transformer, T1, and is rectified by silicon rectifier bridge, A1CR1. The full-wave rectified output is filtered by capacitors, A1C1, A1C2, and series dropping resistor, A1R2. Voltage regulation and additional filtering is achieved by dropping resistor, R1, and two gaseous regulator tubes, V1 and V2, in series to provide an approximate output voltage of 300 Vdc.

The low voltage for the variable pulse rate drive circuit is obtained from two 6.3 V secondary windings of transformer, T1, connected in series, and is rectified by silicon rectifier bridge, A1CR2. The full-wave rectified output is filtered by capacitors A1C3 and A1C9 and series inductance L1.

5.3.2 Polarity Reversing Circuitry

The polarity of the output pulse can be changed by reversing the polarity of the charging voltage to S6, S7 and S8 and to the Impulse Generator, A2K1. The PULSE POLARITY switch, S5, provides this control by reversing the connections of ground and voltage output across the regulator string, V1 and V2.

5.3.3 Attenuator Circuitry

The spectral output level is determined by the dc charging potential. The

charging level is controlled by three attenuator switches, S6, S7 and S8. S6 is a five-position step attenuator which can vary the output level in 0.25 dB steps throughout a 1.0 dB range. S7 is an eleven-position step attenuator which can vary the output level in 1.0 dB steps throughout a 10 dB range. S8 is a twelve-position step attenuator which can vary the output level in 10 dB steps throughout a 110 dB range.

The individual resistors included in the S6, S7 and S8 voltage divider arrangement are accurate to within one percent. This ensures excellent overall attenuator accuracy. Therefore the step attenuator switches are designed so that the impulse generator output can be varied from 0 to 121 dB above 1 microvolt-per-megahertz in 0.25 dB steps. A 4 watt potentiometer, R3, controls the overall spectral output level of the impulse generator.

5.3.4 Impulse Generator Circuitry, A2

The impulse generator, A2, consists of a 38 inch length of open-circuited coaxial line, DL1, in series with a mercury switch, K1. See Figure 5-1.

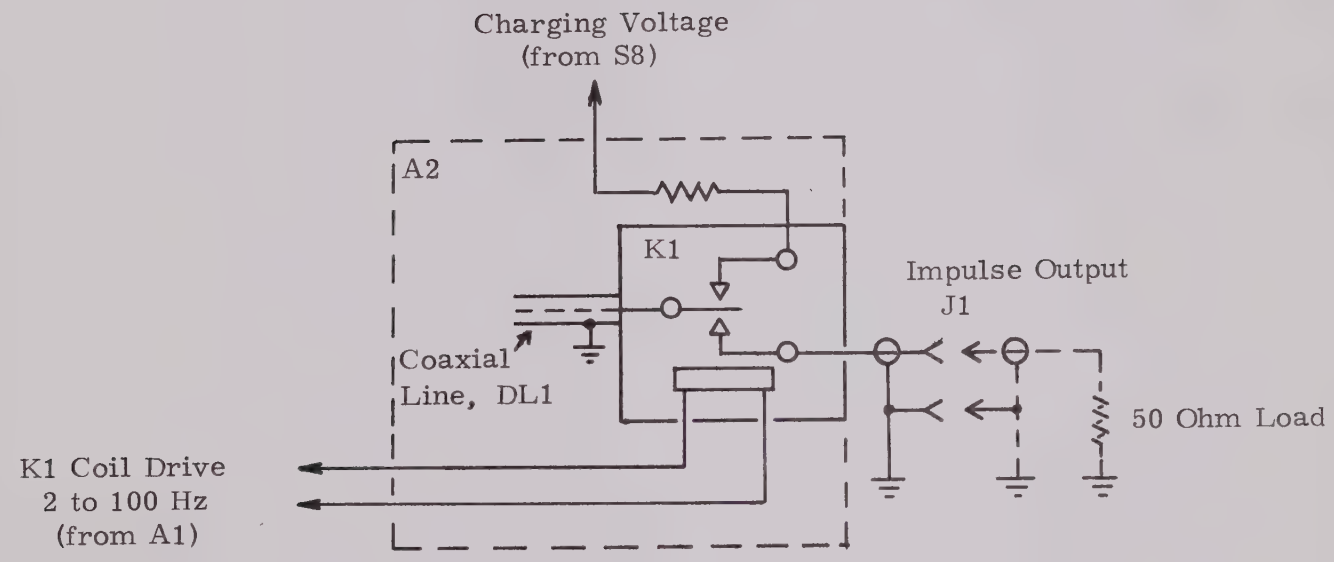


Figure 5-1. Details of Impulse Generator, A2

The outer conductor of the coaxial line is at ground potential while one end of the internal conductor is connected to the arm of a SPDT mercury switch. One switch contact is connected to the calibrated voltage source at the output of the attenuator circuit through a 2.2 megohm resistance, A2R1. The other switch contact is connected to the OUTPUT receptacle, J1. Periodically, the coaxial line is charged, disconnected from the charging source, and discharged into the 50 ohm load. The discharge results in a pulse with a duration determined by the length of the coaxial line. The mercury switch is operated by the relay coil that is driven by the variable rate generator.

5.3.5 Variable Rate Generator Circuitry, A1

The switching rate of the mercury switch impulse generator is determined by the position of the PULSES/SEC control, R32, which controls the charging rate of A1C5 and the associated switching rate of unijunction transistor A1Q1. The output of A1Q1 drives a monostable multivibrator circuit, A1Q2 and A1Q3. The signal output from the A1Q3 collector is amplified by the power amplifier A1Q4 and applied across the mercury switch drive coil, A2K1. The signal output from A1Q3 collector is also coupled through C8 to the SYNC output. For manual operation of the impulse generator, the PULSES/SEC control, R32, is rotated to the MANUAL position which opens switch S3 and prevents A1C5 from charging and A1Q1 from switching. When the MANUAL PULSE pushbutton switch, S4, is depressed, a positive voltage pulse is applied to the input circuit of the monostable multivibrator stage, A1Q2 and A1 Q3,

which operates for one cycle to provide a single pulse output from the impulse generator.

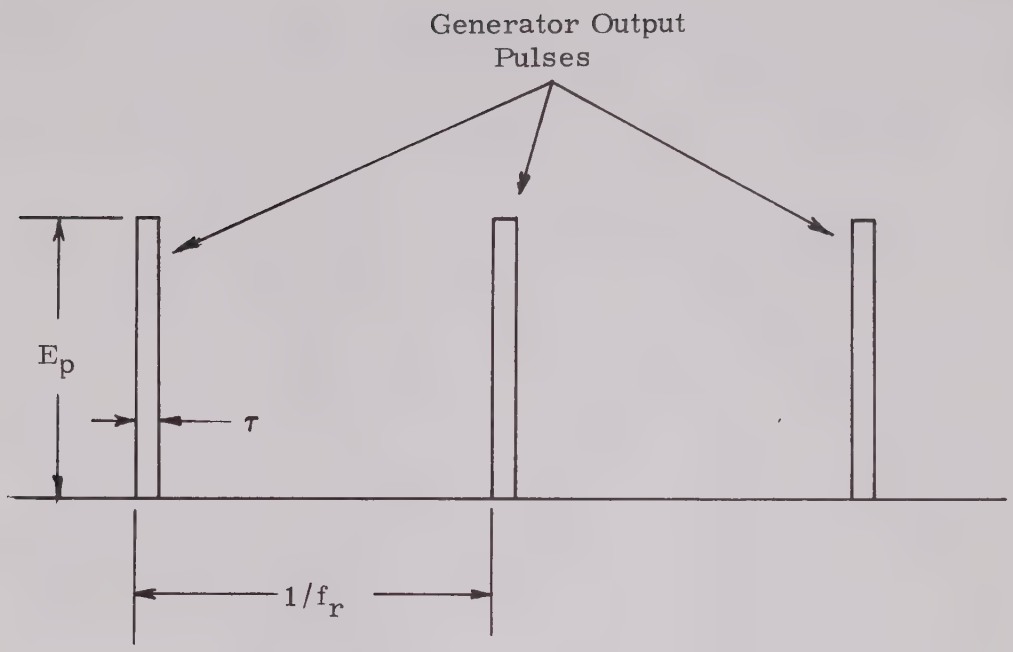
5.3.6 Attenuator Pad

The Model RFA-40 attenuator pad consists of three resistors in a π configuration. Attenuation is constant within ±1 dB from dc to 500 MHz. The pad is used in series with the OUTPUT receptacle from the Model 93453-1 to attenuate low-level spurious output by 40 dB.

5.4 IMPULSE GENERATOR FUNDAMENTALS

An Impulse Generator is an instrument capable of generating rectangular pulses that may be many volts in amplitude for very short durations. Such short duration pulses have a constant spectral intensity over a very wide frequency range.

The output of the Model 93453-1 Impulse Generator is displayed in the time domain in Figure 5-2.



τ = Pulse width of impulse (determined by length of coaxial line- approximately 10 nanoseconds for the Model 93453-1 Impulse Generator)

f_r = Pulse repetition rate

$1/f_r$ = Time interval between pulses

Ep = Peak pulse amplitude (controlled by dc charging potential from S6, S7 and S8)

Figure 5-2. Impulse Generator Waveforms in Time Domain

The output of the 93453-1 Impulse Generator is displayed in the frequency domain in Figure 5-3.

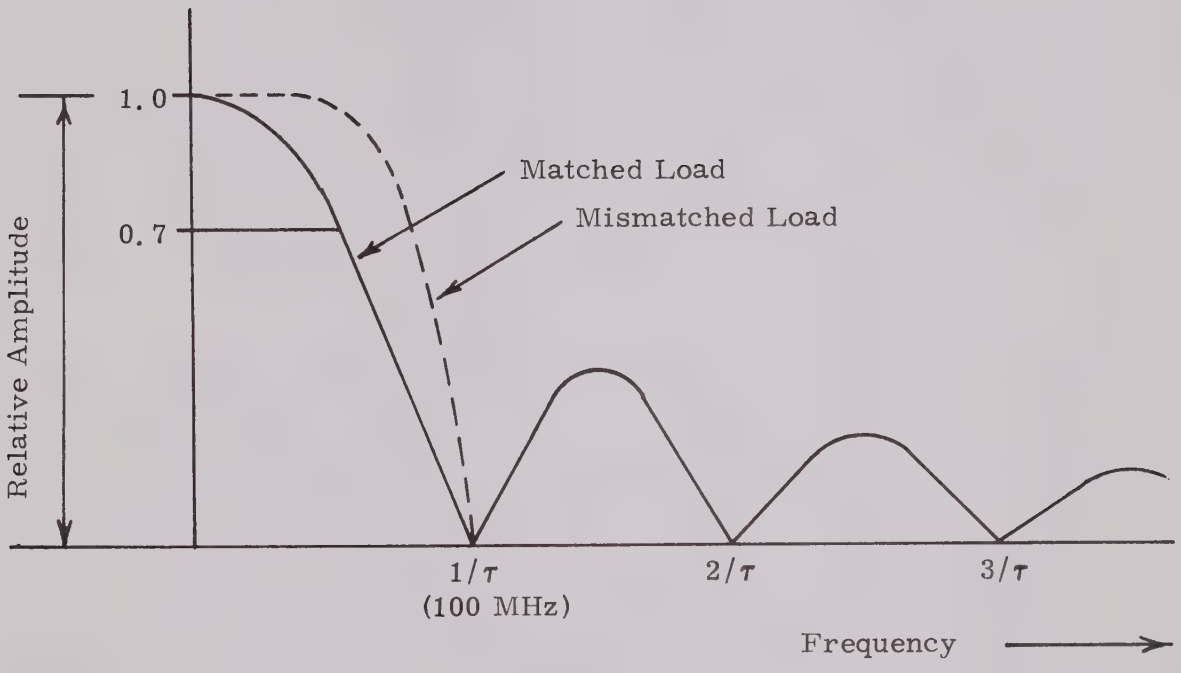


Figure 5-3. Impulse Generator Output in Frequency Domain

When the load has the same impedance as the impulse generator charging line, the spectral intensity of the resultant rectangular pulse on discharge is given by the $\frac{\sin X}{X}$ function. As the duration of the pulse decreases, the width of the first lobe of the $\frac{\sin X}{X}$ function increases. The amplitude spectrum of a rectangular pulse is:

$$A_{(F)} = \frac{\text{Sin } n \pi \tau F}{n \pi \tau F}$$

where: $A_{(F)}$ = Amplitude at computed frequency

τ = Pulse duration in seconds

F = Frequency in hertz

n = 1

The amplitude values at representative frequency points of the theoretical (matched load) Model 93453-1 Impulse Generator curve can be calculated and are displayed in Table 5-1.

Table 5-1. Frequency Versus Amplitude of an Impulse

Frequency	Radians	Relative Amplitude	% of Max	dB Down (approx)
16.6 MHz	$\pi/6$	0.955	95.5	0.5
25 MHz	$\pi/4$	0.901	90.1	1.0
33.3 MHz	$\pi/3$	0.827	82.7	1.5
50 MHz	$\pi/2$	0.636	63.6	4.0
66.6 MHz	$2\pi/3$	0.411	41.1	7.0
75 MHz	$3\pi/4$	0.300	30.0	10.0
100 MHz		0	Null Point	

Using the above data, the flatness of the impulse can be calculated. For example, at 25 MHz the amplitude is down approximately 1 dB. Furthermore, the impulse is flat to 50 MHz (within 4 dB).

However, the spectral flatness of the Model 93453-1 has been extended higher in frequency (see the mismatched load dotted curve of Figure 5-3) by creating a mismatch between the transmission line impedance and the load impedance. The optimum mismatch occurs when $Z_{load}/Z_{line} = 0.74$. RG-179/U coaxial cable has been used for the transmission line, providing a mismatch ratio of $50/70 = 0.7$. The guaranteed spectral flatness of the Model 93453-1 is within ±1 dB up to 35 MHz.

5.5 CALIBRATION TERMS

The Model 93453-1 output is calibrated in terms of dB above one microvolt per megahertz (dBμV/MHz). This is the rms spectral intensity and is in the same broadband terms used for EMI measurements. MIL- STD-463 defines impulse strength as:

> "The rms unmodulated sine wave voltage required to produce in a circuit a peak response equal to that produced by the impulse in question, divided by the impulse bandwidth of the circuit."

Section VI

MAINTENANCE

6.1 INTRODUCTION

This section contains information for the maintenance of the Model 93453-1. Included are minimum performance checks, alignment procedures, and fault isolation procedures.

6.2 MINIMUM PERFORMANCE CHECKOUT AND ADJUSTMENT

Verification of the output level accuracy constitutes the Minimum Performance Checkout procedure. Due to the involved calibration procedure, it is recommended that the instrument be returned to the factory for necessary calibration. If this is not convenient, refer to MIL- STD-462, "Electro Magnetic Interference Characteristics, Measurements of," Paragraph 4.2.3.6, Impulse Generators.

6.3 DISASSEMBLY PROCEDURES

a. Remove the two 8-32 x 3/8" Philips-head screws from the back of the instrument.

b. Slide the instrument out of the case.

> WARNING
> 500 volts is developed by the power supply and, depending on the attenuator settings, 300 volts can be applied to the mercury switch assembly, A2.

6.4 ALIGNMENT AND ADJUSTMENT

When calibrating the output level (spectral intensity) of the Model 93453-1 Impulse Generator in accordance with MIL-STD-462, Paragraph 4.2.3.6, perform the calibration as given and adjust chassis mounted control R3 to produce the desired output level accuracy.

6.5 FAULT ISOLATION PROCEDURE

If no output pulse is obtained, check the following with the attenuator dials adjusted for maximum output level and the PULSE POLARITY switch set to the + position.

a. Examine the fuse. Replace with a new fuse if necessary.

b. Check voltage at the charging line (terminal 1 on A2 PC board). It should be from +200 to +300 volt dc, depending upon the setting of R3. If no voltage appears, check the voltage regulator tubes or the rectifier bridge, A1CR1.

c. A faint ticking or buzzing sound should be heard from the mercury switch relay, A2K1, when the PULSES/SEC control is adjusted through its range. If this sound is not heard, check the coil driving voltage with an oscilloscope (pins 6 and 13 on A1 PC board). This should be approximately 15 volts peak-to-peak, see waveform shown on schematic, Figure 8-1.

Section VII

REPLACEABLE PARTS

7.1 INTRODUCTION

This section contains information for ordering replacement parts. Table 7-1 lists the parts of the Model 93453-1. Parts are listed in the alpha-numerical order of their reference designators and indicate the description, the Singer part number, the typical manufacturer of the part in a five-digit code, and the manufacturer's part number. Table 7-2 lists the typical manufacturers in numerical code number order.

Table 7-1. Parts List for Main Assemblies and Chassis Parts

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
A1	I. G. drive and power rectifier assembly	1-004797-001	88869	
A2	Relay assembly	1-005016-001	88869	
DL1	Pulse forming line, delay line	S93751-2	88869	
DS1	Lamp, glow, T3 1/4 bulb, min. bayonet base, 56 Vdc	SNE51	24446	NE51
F1	Fuse, cartridge, Slo-Blo: 0.4 amp, 250 V	1-924005-113	75915	313.400
J1	Connector, receptacle, BNC, bulkhead, UG-909 B/U	1-910017-007	95712	2230-7
J2	Connector, receptacle, BNC, bulkhead, UG-1094/U	1-910132-002	11636	KC-74-06
L1	Inductor, fixed: 700 mH	1-906041-001	81095	C-27X
P1	Plug, 3-pin, part of W1			
R1	Resistor, fixed, wirewound, 8200 ohms, ±5%, 10 W	S18350-822	91637	Type RS-10
R2	Resistor, fixed, composition, 150 kilohms, ±5%, 1/2 W	S10011-154	01121	EB1545
R3	Resistor, variable, wirewound, 20 kilohms, ±10%, 3 W	S18344	90201	Type R20ML
R4	Not used			
R5	Resistor, fixed, deposited carbon: 1305 ohms, ±1%, 1/2 W	S10935-7	11350	Type FCA15
R6	Resistor, fixed, deposited carbon: 1268 ohms, ±1%, 1/2 W	S10935-6	11350	Type FCA15
R7	Resistor, fixed, deposited carbon: 1232 ohms, ±1%, 1/2 W	S10935-5	11350	Type FCA15
R8	Resistor, fixed, deposited carbon: 1195 ohms, ±1%, 1/2 W	S10935-4	11350	Type FCA15

Table 7-1. Parts List for Main Assemblies and Chassis Parts (Cont.)

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R9	Resistor, fixed, wirewound, 41 kilohms, ±1%, 10 W	S18350-413	91637	Type RS-10
R10	Resistor, fixed, deposited carbon: 123 kilohms, ±1%, 1/2 W	S10935-12	11350	Type FCA15
R11	Resistor, fixed, deposited carbon: 137 kilohms, ±1%, 1/2 W	S10935-13	11350	Type FCA15
R12	Resistor, fixed, deposited carbon: 154 kilohms, ±1%, 1/2 W	S10935-14	11350	Type FCA15
R13	Resistor, fixed, deposited carbon: 169 kilohms, ±1%, 1/2 W	S10935-15	11350	Type FCA15
R14	Resistor, fixed, deposited carbon: 196 kilohms, ±1%, 1/2 W	S10935-16	11350	Type FCA15
R15	Resistor, fixed, deposited carbon: 218 kilohms, ±1%, 1/2 W	S10935-18	11350	Type FCA15
R16	Resistor, fixed, deposited carbon, 243 kilohms, ±1%, 1/2 W	S10935-19	11350	Type FCA15
R17	Resistor, fixed, deposited carbon, 272 kilohms, ±1%, 1/2 W	S10935-20	11350	Type FCA15
R18	Resistor, fixed, deposited carbon, 308 kilohms, ±1%, 1/2 W	S10935-21	11350	Type FCA15
R19	Resistor, fixed, deposited carbon, 340 kilohms, ±1%, 1/2 W	S10935-22	11350	Type FCA15
R20	Resistor, fixed, deposited carbon, 684 kilohms, ±1%, 1/2 W	S10935-23	11350	Type FCA15
R21	Resistor, fixed, deposited carbon, 216 kilohms, ±1%, 1/2 W	S10935-17	11350	Type FCA15
R22	Resistor, fixed, deposited carbon, 68.4 kilohms, ±1%, 1/2 W	S10935-11	11350	Type FCA15

Table 7-1. Parts List for Main Assemblies and Chassis Parts (Cont.)

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R23	Resistor, fixed, deposited carbon, 21.6 kilohms, ±1%, 1/2 W	S10935-10	11350	Type FCA15
R24	Resistor, fixed, deposited carbon, 6.84 kilohms, ±1%, 1/2 W	S10935-9	11350	Type FCA15
R25	Resistor, fixed, deposited carbon, 2.16 kilohms, ±1%, 1/2 W	S10935-8	11350	Type FCA15
R26	Resistor, fixed, deposited carbon, 684 ohms, ±1%, 1/2 W	S10935-3	11350	Type FCA15
R27	Resistor, fixed, deposited carbon, 216 ohm, ±1%, 1/2 W	S10935-2	11350	Type FCA15
R28	Resistor, fixed, deposited carbon, 68.4 ohms, ±1%, 1/2 W	S10935-27	11350	Type FCA15
R29	Resistor, fixed, deposited carbon, 21.6 ohms, ±1%, 1/2 W	S10935-26	11350	Type FCA15
R30	Resistor, fixed, deposited carbon, 6.84 ohms, ±1%, 1/2 W	S10935-25	11350	Type FCA15
R31	Resistor, fixed, deposited carbon, 3.0 ohms, ±1%, 1/2 W	S10935-24	11350	Type FCA15
R32/S3	Variable resistor/switch assembly R32: 400 kilohm ±10%, 2 W	S18342	01121	Type J
S1	Switch, toggle, DPDT; 125 V, 3 amp., 250 V, 1 amp.	S10172	95691	83054
S2	Switch, slide, DPDT	1-951003-001	82389	46206-LF
S3	Switch, rotary, SPST, (part of R32)			
S4	Switch, pushbutton, momentary SPST, normally open contact	S12163	81073	23-1

Table 7-1. Parts List for Main Assemblies and Chassis Parts (Cont.)

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
S5	Switch, toggle, DPDT, 125 V 3 amp., 250 V 1 amp.	S10172	95691	83054
S6	Switch, rotary: single pole, 11 positions, adjustable stop	S18335	88869	
S7	Switch, rotary: single pole, 11 positions, adjustable stop	S18335	88869	
S8	Switch, rotary: single pole 12 positions	S18336	88869	
T1	Transformer, power	2-403752-001	73386	
V1	Electron tube, type OA2	1-917009-001	24446	OA2
V2	Electron tube, type OA2	1-917009-001	24446	OA2
W1	Cable, AC power	1-910166-002	70903	
XDS1	Lampholder	S11441	74970	147-1142
XF1	Fuseholder	1-924007-001	75915	341001

Table 7-1. Parts List for Rectifier-Mercury Switch Drive Assembly, A1

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
Ref	PC Board	4-103841-001	88869	
C1	Capacitor, fixed, metallized mylar: 1 μF ±20 %, 1 kV	1-900125-001	0000A	D10-105
C2	Capacitor, fixed, metallized mylar: 2.0 μF, 600 V	S11880	99515	D-130
C3	Capacitor, fixed, electrolytic, 100 μF, ±10%, 15 V	1-900000-014	56289	TE 1211
C4	Capacitor, fixed, mylar, 0.05 μF, ±10%, 250 V	1-900001-109	73445	C280AE
C5	Capacitor, fixed, mylar, 1.0 μF, ±10%, 250 V	1-900001-125	73445	C280AE
C6	Capacitor, fixed, mylar, 0.47 μF, ±10%, 250 V	1-900001-121	73445	C280AE
C7	Capacitor, fixed, mylar, 0.10 μF, ±10%, 250 V	1-900001-113	73445	C280AE
C8	Capacitor, fixed, mylar, 0.01 μF, ±10 %, 250 V	1-900001-101	73445	C280AE
C9	Capacitor, fixed, electrolytic, 50 μF, ±10%, 50 V	1-900023-024	56289	TE-1307
CR1	Rectifier, bridge, silicon, Vr = 1000 V, If = 1.8 A	1-913079-001	04713	MDA 922-9
CR2	Rectifier, bridge, silicon, Vr = 25 V, If = 1.8 A	1-913079-002	04713	MDA 922-1
CR3	Diode, silicon, Vr = 35 Vrms	1-913001-001	04713	1N40001

Table 7-1. Parts List for Rectifier-Mercury Switch Drive Assembly, A1 (Cont.)

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
Q1	Transistor, silicon	1-958050-001	04713	2N2646
Q2	Transistor, silicon, NPN	1-958000-101	04713	2N3904
Q3	Transistor, silicon, NPN	1-958000-001	04713	2N3904
Q4	Transistor, silicon, PNP	1-958001-001	04713	MJE370
R1	Resistor, fixed, composition, 750 ohms, ±5%, 2 W	1-945003-159	01121	HB7515
R2	Resistor, fixed, composition, 750 ohms, ±5%, 2 W	1-945003-159	01121	HB7515
R3	Resistor, fixed, composition, 5.6 k ohms, ±5%, 1/4 W	1-945000-180	01121	CB5625
R4	Resistor, fixed, composition, 100 k ohms, ±5%, 1/4 W	1-945000-210	01121	CB1045
R5	Resistor, fixed, composition, 360 ohms, ±5%, 1/4 W	1-945000-151	01121	CB3615
R6	Resistor, fixed, composition, 5.6 k ohms, ±5%, 1/4 W	1-945000-180	01121	CB1835
R7	Resistor, fixed, composition, 27 ohms, ±5%, 1/4 W	1-945000-124	01121	CB2705
R8	Resistor, fixed, composition, 560 ohms, ±5%, 1/4 W	1-945000-156	01121	CB5615
R9	Resistor, fixed, composition, 5.6 k ohms, ±5%, 1/4 W	1-945000-180	01121	CB1835
R10	Resistor, fixed, composition, 5.6 k ohms, ±5%, 1/4 W	1-945000-180	01121	CB1835
R11	Resistor, fixed, composition, 56 ohms, ±5%, 1/4 W	1-945000-132	01121	CB5605

Table 7-1. Parts List for Rectifier-Mercury Switch Drive Assembly, A1 (Cont.)

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R12	Resistor, fixed, composition, 560 ohms, ±5%, 1/4 W	1-945000-156	01121	CB5615
R13	Resistor, fixed, composition, 10 ohms, ±5%, 1/4 W	1-945000-114	01121	CB1005
R14	Resistor, fixed, composition, 10 k ohms, ±5%, 1/4 W	1-945000-186	01121	CB1035
R15	Not used			
R16	Not used			
R17	Resistor, fixed, composition, 10 ohms, ±5%, 1/4 W	1-945000-114	01121	CB1005

Table 7-1. Parts List for Relay Assembly, A2

Ref. Design.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
Ref	PC Board	4-103861-001	88869	
C1	Capacitor, fixer, ceramic, 0.005 μF +80% -20%, 1 kV	1-900012-004	72982	801Z5U 502Z
K1	Relay, mercury wetted contacts, SPDT	1-942026-001	70109	AWCY-16081-1
R1	Resistor, fixed, composition, 2.2 meghom, ±5%, 1/4 W	1-945000-242	01121	CB2255
R2	Resistor, fixed, composition, 4.7 kilohm, ±5%, 1/4 W	1-945000-178	01121	CB4725

Table 7-2. Code List of Manufacturers

Code No.	Manufacturer	Address
01121	Allen-Bradley Company	Milwaukee, Wisc.
04713	Motorola, Inc.	Phoenix, Ariz.
11350	Penn Resistor Corp.	Lansdale, Pa.
11636	Kings Electronics Co.	Pasadena, Calif.
24446	G. E. Corp.	Schenectady, N. Y.
56289	Sprague Electric Co.	North Adams, Mass.
70109	Adams and Westlake Co.	Elkhart, Ind.
70903	Beldon Corp.	Chicago, Ill.
72982	Erie Tech. Products Co.	Erie, Penn.
73386	Freed Transformer Co.	Brooklyn, N. Y.
73445	Amperex Electronics Co.	Hicksville, N. Y.
75915	Littelfuse, Inc.	Des Plaines, Ill.
81073	Grayhill, Inc.	La Grange, Ill.
81095	Triad Transformer Co.	Venice, Calif.
82389	Switchcraft, Inc.	Chicago, Ill.
88869	Singer Instrumentation	Los Angeles, Calif.
90201	Mallory Capacitor Co.	Indianapolis, Ind.
91637	Dale Electronics, Inc.	Columbus, Neb.
95691	Arrow-Hart, Inc.	Hartford, Conn.
95712	Bendix Corp.	Franklin, Ind.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
0000A*	ITT Jennings	Monrovia, Calif.

*This vendor has no listing in the latest supplement to the Federal Supply Code for Manufacturers Cataloging Handbook H4-1.

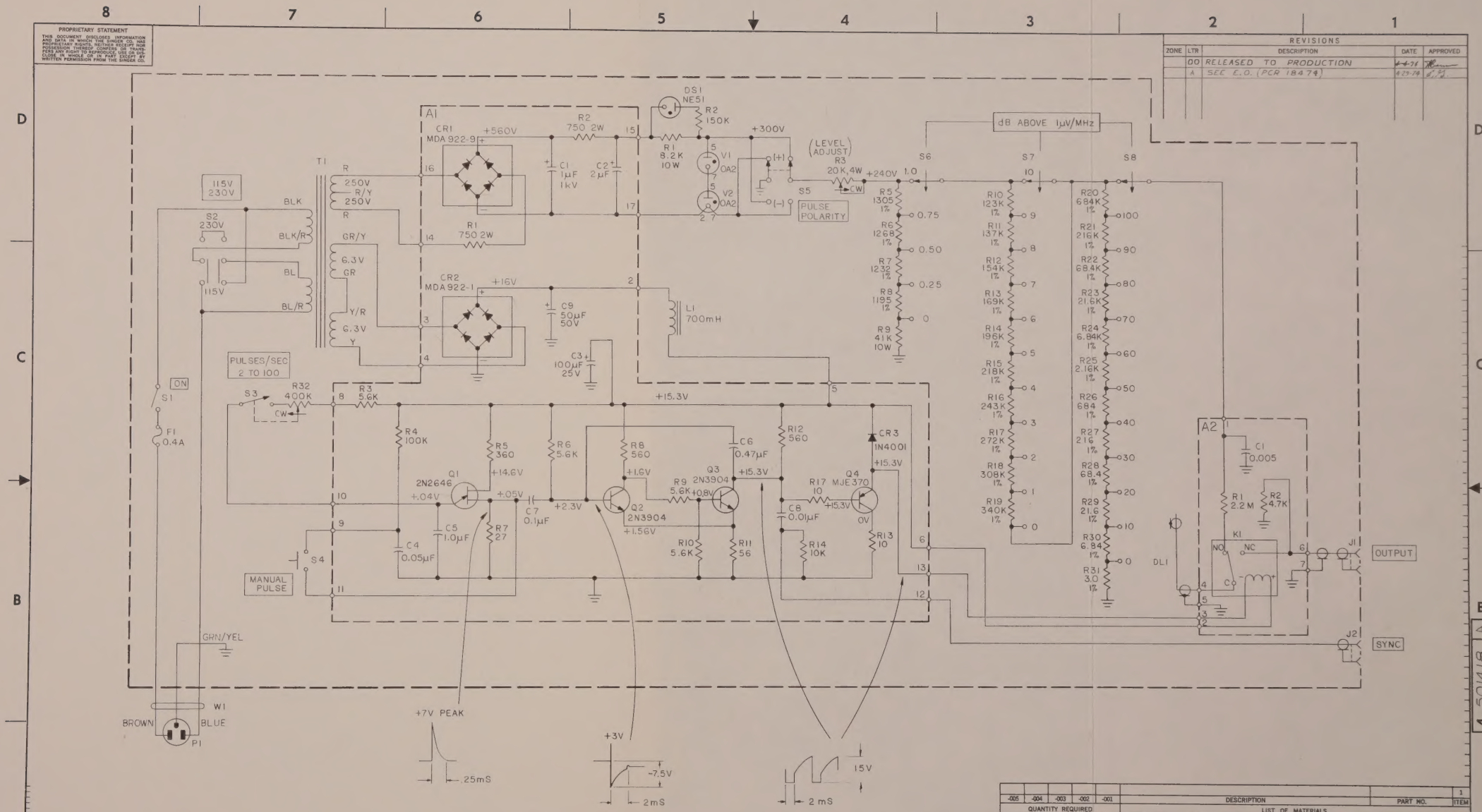


Figure 8-1. Impulse Generator Model 93453-1, Schematic Diagram